Television shows like *Law and Order*, *Forensic Files*, and *CSI* have introduced forensic science to popular audiences and dramatically demonstrated the importance of establishing time of death, or post-mortem interval (PMI), in order to solve crimes. However, PMI is more than a plot device; accurate evaluation of time of death is critical to creating an accurate timeline of events, identifying or eliminating suspects, and providing vital information regarding the circumstances surrounding the end of a person's life. In cases of unknown remains, PMI may also facilitate identification. Not only does PMI play a central roles in criminal investigations and the ability to bring criminals to justice, it also helps loved ones fill in the blanks regarding their loss and find the closure they need to begin the healing process. As technological advances increasingly perfect the precision of forensic investigations, spectral analysis is expanding the possibilities for determining PMI in challenging conditions.

The Challenge of Skeletal Remains

Determination of PMI usually relies on observing the state of the flesh. Soft tissue undergoes distinct stages of decomposition and becomes host to microbial and insect ecosystems, allowing forensic investigators to estimate how long the body has been lifeless with significant accuracy based on specific physical presentation.[1] However, once the flesh has disintegrated and only the skeleton remains, this rich tapestry of clues disappears and the process of establishing time of death becomes much more challenging, presenting serious obstacles to investigators. This is of particular concern in areas with environments conducive to rapid decomposition, such as hot, wet climates that quickly strip the body of easily accessible PMI information.

Towards a Statistical Regression Model

In recent years, researchers at the Center for Analytic Spectroscopy at Baylor University have developed a statistical model for dating skeletal remains based on spectral data. Although much more subtle than the decomposition of the flesh, over time bones also undergo significant structural changes that can provide vital information regarding PMI. By using diffuse reflectance spectrophotometry, the research team was able to track the progression of moisture loss and protein breakdown in bones over a period of three months and "correlate the data with the post-mortem interval by using regression modeling."[2] Spectral analysis was performed on 28 pig bones with a PMI of up to 90 days; the longer the PMI, the less spectral reflectance was observed. Using the statistical regression model, the PMI was accurate within four to nine days for bones as old as 90 days. As the methodology is refined, it is likely that the error rate will be even lower.

The Benefits of Spectral Analysis

Diffuse reflectance spectrophotometry was chosen in part due to its high sensitivity to moisture and protein levels, providing precise quantification of water and protein at even low concentrations. Its non-destructive qualities ensure detailed measurements without disturbing the skeletal remains, enabling forensic investigators to obtain rapid results without time-consuming sample preparation. As Dr. Kenneth Busch, lead researcher on the study, noted, "Once a regression model is built from spectral data, you could find out the age of the bones in a matter of minutes, rather than taking hours or days." This method also eliminates the possibility of sample preparation errors that can compromise a criminal case. Furthermore, allowing remains to stay intact preserves evidence for further analytical study or to present in a courtroom.

Full article with photos available here:

https://www.hunterlab.com/blog/color-measurement-2/what-remains-spectral-analysis-expands-possibilities-in-forensic-science/